FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 2345/79
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/341232

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATES CLAIMED
PCT/EP98/00027	(05.01 98) 05 January 1998	(06.01.97) 06 January 1997

TITLE OF INVENTION
METHOD FOR GENERATING A NETWORK

APPLICANT(S) FOR DO/EO/US
Volker ERNST; Björn WERTHER; Manfred WERTHER; Frank WILLE; Roman-Emanuel ZGOLL

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (unsigned).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report, International Preliminary Examination Report, and Form PCT/RO/101.

Express Mail No. EL 303 28 546 9US

510 Rec'd PCT/PTO 06 JUL 1999

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/341232	PCT/EP98/00027	2345/79

17. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO $840.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) ... $670.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $760.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $970.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	24 - 20 =	4	X $18.00	$ 72	
Independent Claims	2 - 3 =	0	X $78.00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $260 00	$	
TOTAL OF ABOVE CALCULATIONS =				$912	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$912	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			+	$	
TOTAL NATIONAL FEE =				$912	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property			+	$	
TOTAL FEES ENCLOSED =				$912	
				Amount to be refunded	$
				charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of $912.00 to cover the above fees. A duplicate copy of this sheet is enclosed

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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7/6/99
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202961

[2345/79]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Volker ERNST et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	METHOD FOR GENERATING A NETWORK
Examiner	:	To Be Assigned
Group Art Unit	:	To Be Assigned

Assistant Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Kindly amend the above-identified application before examination as follows:

IN THE SPECIFICATION:

On page 1, delete line 1, and insert:

--FIELD OF THE INVENTION--.

On page 1, line 3, change "concerns" to --relates to--.

On page 1, before line 7, insert:

--BACKGROUND INFORMATION--.

On page 5, before line 3, insert:

--SUMMARY OF THE INVENTION--.

On page 5, line 3, delete "therefore".

On page 5, line 29, change "the process steps I-IV" to --the above-described process steps--.

On page 6, line 14, change "drawn up" to --generated--.

On page 7, delete lines 15-32.

On page 8, delete lines 1-33.

On page 9, delete lines 1-9, and insert:

--BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a territory having individual users arranged along streets.

Figure 2 shows the territory which was manually divided into areas A-E by a network planner using conventional methods.

Figure 3 shows a network plan for the territory which was drawn up manually by a network planner using conventional methods.

Figure 4 shows a graph inserted into the territory using a method according to the present invention, one edge for graph being provided along each side of each street.

Figure 4a shows a section of the territory illustrated in Figure 4, in which the method according to the present invention connects the users to the graph via service edges.

Figure 4b shows a section of the territory in which a tree structure is created by connecting the users step by step to a portion of the tree structure already created.

Figure 4c shows the tree structure created for the territory using the method according to the present invention and a load assigned to the edges.

Figure 5 shows the territory having cable distribution sub-areas created

according to the present invention.

Figure 5a shows a section of the territory 1 with two cable distribution sub-areas being combined to form one cable distribution area.

Figure 5b shows a first section of Figure 5a, with the cable distribution area being separated from the tree structure by two limit edges.

Figure 5c shows a second section of Figure 5a, with the limit edge of the cable distribution sub-area being connected to a closest node with a particular requirement.

Figure 6 shows the territory having the created cable distribution areas and cable distributors arranged in their distribution centers.

Figure 7 shows a new tree structure created using a process according to the present invention.

Figure 8 shows the cable distribution areas, with pairings being assigned to individual edges or street segments.

DETAILED DESCRIPTION--.

On page 14, line 4, change "on the basis of" to --with respect to--.

On page 14, delete lines 21-22, and insert:

--26.--

On page 15, line 24, delete "The".

On page 15, delete lines 25-27, and insert:

--As shown in Figure 6, the--.

On page 16, line 22, before "Figure", insert --see--.

On page 23, delete the first line, and insert:
--What Is Claimed Is:--.

IN THE ABSTRACT:

On page 34, delete line 1, and insert:
-- ABSTRACT OF THE DISCLOSURE--.

On page 34, delete lines 3-31, and insert:

--A method for generating a network, in particular a telecommunications, water, long-distance heat supply, or power network, the network connecting all users to a main distribution node depending on the existing or definable local needs and requirements of the individual users. A graph is generated which is composed of edges and nodes. The graph includes all technically feasible and/or definable transmission paths of the network. The length and direction of the edges are derived from the real topography of the street segments and definable cable paths of the territory to be supplied by the network. The nodes form the intersections between the edges or streets and/or cable paths. The users are assigned to the graph in such a way that each user is connected to the closest edge or the closest node of the graph by an additional service edge. A tree structure is created by removing unnecessary edges from the graph in such a way that the service edges, edges, and nodes of the tree structure form only one connection between the main distribution node and each user. The load of the edges in the tree structure is determined depending on the needs and requirements of the users.--.

IN THE CLAIMS:

Please cancel original claims 1-20, and please cancel substitute

claims 1-20, without prejudice.

Please add new claims 21-44, as follows:

--21. (New) A method for generating a network which connects all users residing within a particular territory to a main distribution node, comprising the steps of:

a) generating a network plan using the following substeps:

i) generating a graph which represents the network and which is composed of edges and nodes, the edges representing all transmission paths in the network, wherein a length and a direction of each of the edges is determined as a function of a real topography of street segments and definable cable paths of a particular territory associated with the network, the nodes representing intersections between at least one of the street segments and the definable cable paths,

ii) assigning the users to the graph, each of the users being connected to one of a closest edge of the edges and a closest node of the nodes via at least one service edge,

iii) generating a tree structure by removing unnecessary edges of the edges from the graph so that only one particular connection exists between the main distribution node and each of the users, wherein the particular connection is composed of the at least one service edge, the edges and the nodes of the tree structure,

iv) determining needs and requirements for each of the users, and

v) determining at least one load of the edges of the tree structure as a function of the needs and the requirements for each of the users

to provide a drafted plan; and

b) generating the network according to the drafted plan.

22. (New) The method according to claim 21, wherein step (a) includes the substep of:

vi) delimiting areas of the graph, and dimensioning and selecting a particular technology to be used for each of the edges, the at least one service edge and the node of the tree structure as a function of the at least one load.

23. (New) The method according to claim 22, wherein substep (a)(ii) includes the substep of splitting the closest edge in the graph into two edges at a junction between the closest edge and the at least one service edge, and wherein the junction forms a further node.

24. (New) The method according to claim 21, wherein substep (a)(iii) includes the substeps of:

A) determining a particular user of the users who has a first path of the transmission paths to the main distribution node along the graph which generates lowest provisioning costs compared to remaining users of the users, and marking the particular user, first edges of the edges and first nodes of the nodes which form the first path,

B) after substep (a)(iii)(A), selecting an unmarked user of the users has a second path of the transmission paths to the main distribution node which is a most economical path, the most economical path being determined using the first edges and the first nodes, and marking the unmarked user, second edges of the edges and second nodes of the node, the second edges and the second nodes forming the

second path,

C) repeating substep (a)(iii)(B) until all of the users are marked, and

D) removing particular edges of the edges and particular nodes of the node from the graph, the particular edges and the particular node being unmarked.

25. (New) The method according to claim 21, further comprising the steps of:

c) storing first data of the real topography and second data of the definable cable paths in a first database; and

d) storing third data of the users in a second database, the second database storing an address, junction coordinates and the requirements for each of the users.

26. (New) The method according to claim 25, wherein the graph and the tree structure is generated from the first and second data stored in the first database, and from the third data stored in the second database.

27. (New) The method according to claim 21, wherein each street segment in the particular territory is defined by two particular edges of the edges during substep (a)(ii), each of the two particular edges representing one side of a particular segment of the street segments.

28. (New) The method according to claim 27,

wherein the users are capable of being connected to the main distribution node using further connections via different-type transmission lines, each of the further connections has a respective transmission capacity and a respective maximum range, the further connections being distinguished from one another using the respective transmission capacities and the respective maximum ranges, and

wherein cables of the cable paths have different numbers of copper pairs wires or glass fibers, the users being supplied by a particular cable of the cables so that at least one of telephone lines and data lines of the transmission lines which are necessary needed for a first user of the users is capable of extending from the particular cable, passing a second user of the users and leading to a third user of the users.

29. (New) The method according to claim 27, wherein each of the segments is delimited and dimensioned, and the particular technology to be used for each of the edges is determined according to the following substeps:

A) defining at least one of the respective transmission capacity of cable distributors and the respective maximum range of a transmission equipment to be used for at least one cable distribution area, the capacity being determined from the transmission equipment,

B) selecting to a particular user of the users having the at least one service edge which is connected to a particular node of the nodes which is connected to only one further edge of the edges,

C) starting at the particular user, extending the at least one service edge, the edges and the nodes of the tree structure in a direction of an exchange to reach a limit edge, the limit edge bordering a further node of the nodes which is connected to a further edge of the edges, the further edge having a respective load exceeding at least one of the respective transmission capacity and the respective maximum range of one of the cable distributors and the at least one cable distribution area,

D) marking specific users of the users which are connected to the exchange via the limit edge, and assigning each of the specific users to a respective cable distribution subarea, and

E) repeating steps B) through D) until all the users are assigned to respective cable distribution subareas.

30. (New) The method according to claim 29,

wherein, after substep (E), all of the respective cable distribution subareas are recursively combined into the at least one cable distribution area so that the at least one load of each of the at least one cable distribution area does not exceed the capacity of a respective distributor of the cable distributors, and

wherein each of the users is assigned to only one cable distribution area.

31. (New) The method according to claim 29, wherein a particular subarea of the cable distribution subareas is not combinable with an adjacent subarea of the cable distribution subareas which has a particular load that is smaller or equal to the respective load of the particular subarea, and wherein the particular subarea is combined with another subarea of the at least one cable distribution area to form a larger cable distribution subarea by selecting the particular subarea from the tree structure.

32. (New) The method according to claim 29, wherein only particular subareas of the cable distribution subareas which are directly adjacent to one another are combined into the at least one cable distribution area.

33. (New) The method according to claim 30, further comprising the substeps of:

F) after substep (E), searching the tree structure for at least one further subarea of the respective cable distribution subareas, the at least one further subarea having a first

load which is combined with a second load of a directly adjacent subarea of the respective cable distribution subareas, the second load being smaller or equal to the first load, the directly adjacent subarea having a respective limit edge which borders on a same node of the nodes of the at least one further subarea, the first load having a respective capacity which is greater than the capacity of the cable distributor,

G) combining additional subareas of the cable distribution subareas which are located in the tree structure into a particular area of the at least one cable distribution area, the additional subareas excluding smallest subareas of the at least one cable distribution subarea,

H) removing the additional subareas from the tree structure, and ignoring the additional subareas when generating at least one remaining area of the at least one cable distribution area to separate or ignore all of the users, the service edges, the edges and the nodes connected to the exchange by the limit edge from the tree structure, the respective load of the separated areas being subtracted from the respective load of all of the edges which connect the edges to the exchange, and

J) determining if any further limit edge of the additional subareas borders a further node of the nodes which connects the separated areas to the exchange, wherein, if the further limit edges are not present, a connecting node of the nodes, further edges of the edges and further nodes of the nodes which connect the connecting node to a next node on which the further limit edge borders are removed.

34. (New) The method according to claim 33, wherein further cable distribution areas are generated using the following substeps:

K) checking if the connecting node is connected to a single edge of the edges and to the limit edge, the respective load of the single edge being greater than all other edges which are provided in the tree structure,

L) if a sum of the respective loads of the respective cable distribution subareas adjacent to the connected node is less than or equal to the capacity of the cable distributor, combining all of the respective cable distribution subareas into a further cable distribution subarea having a particular load which is equal to the sum of the respective loads, and performing substep (a)(I),

M) if the sum of the respective loads is greater than the capacity of the cable distributor, combining adjacent subareas of the cable distribution subareas having largest respective loads, the largest respective load being smaller than the capacity of the cable distributor, and forming the further cable distribution subarea,

N) removing the further cable distribution subarea from the tree structure, or ignoring the further cable distribution subareas when creating the at least one cable distribution area, subtracting the respective load of an eliminated area of the at least one cable distribution area from an assigned load of particular edges which connect the particular area to the exchange, if any of the respective cable distribution subareas are attached to the tree structure, performing substep (F), and ending the generation of the network if

none of the cable distribution subareas are attached to the tree structure,

O) assigning the respective particular edge which connects the connected node to the exchange as a further limit edge of a new cable distribution subarea,

P) if the further limit edge is adjacent to a further node of the nodes on which no further limit edges border, determining a next node of the nodes on which another limit edge borders by starting from the further limit edge and extending toward the exchange,

Q) if no further nodes are found in substep (P), assigning the further cable distribution subarea to the particular area of the at least one cable distribution area and completing the generation of the network, and

R) connecting the limit edge of the further cable distribution subarea to the further node, and repeating substeps (F) through (O).

35. (New) The method according to claim 29, wherein, after the at least one cable distribution area is completed, performing the following substeps:

S) determining a distribution center of each of the at least one cable distribution area in relation to a location and the requirements of each of the users who are assigned to the at least one cable distribution area, wherein one of the nodes of the at least one cable distribution area forms the distribution center and simultaneously forms a junction between the cable distribution area and the network being generated,

T) assigning the respective load of the at least one cable distribution area to the distribution center,

U) generating a further tree structure, marking all of the nodes and all of the edges of the tree structure generated in substep (a)(ii) which connect the distribution centers defined as nodes to the exchange, and removing or ignoring unmarked users of the users, unmarked service edges of the service edges, unmarked nodes of the nodes and unmarked edges of the edges from the further tree structure.

36. (New) The method according to claim 33,

wherein each of additional users of the users having the respective loads which are greater than the capacity of the cable distributor are defined as a single area of the at least one cable distribution area prior to completing substep (F), each of the additional users being assigned with a predetermined number of connections to cover particular requirements of each of the further users,

wherein the next node is assigned with a further requirement for a further tree structure which is a multiple of the capacity to cover the requirements of each of the additional users, and each of the additional users is removed from the further tree structure, the next node forming one of the distribution center and the location of the cable distributor assigned to the next user.

37. (New) The method according to claim 21, wherein substep (a)(iv) includes assigning a "0" load to all of the edges of the tree structure, moving from a particular user of the users to a next user of the users along at least one particular edges of the edges and the nodes in a direction of an exchange, and adding the requirements of the particular user to each of the at least one particular edge.

38. (New) The method according to claim 29, wherein each of the segments is delimited and dimensioned according to the following substeps:

V) assigning a load value of "0" to all of the edges in the tree structure,

W) moving from an additional user of the users along at least one particular edge of the edges and at least one particular node of the nodes to the cable distributor of the at least one cable distribution area which belongs to the additional user, and adding the requirements of the additional user to the at least one particular edge,

X) assigning a cable to each respective edge of the edges, the cable having the capacity which covers the respective load of the respective edge, and

Y) assigning a transmission equipment to each respective node of the nodes, the transmission equipment covering the respective load of the respective node.

39. (New) The method according to claim 38, wherein substeps (a)(iv), substeps (A) to (U), and substeps (V) to (Y) are applied to a further tree structure after substep (U), and wherein a different capacity and a different range is defined for further cable distribution areas to be created on a new tree level in substep (A).

40. (New) The method according to claim 21, wherein the network includes one of a telecommunication network, a water network, a district heating network and a power network.

41. (New) The method according to claim 22, wherein the technology relates to one of a cable and a line to be provided.

42. (New) The method according to claim 27, wherein the two edges extend in parallel with respect to one another.

43. (New) The method according to claim 28, wherein the transmission lines include one of copper lines, copper pairs and glass fibers.

44. (New) A set of instructions residing in a storage medium, the set of instructions capable of being executed by a processor to implement a method for generating a network which connects all users residing within a particular territory being supplied to a main distribution node, the method comprising the steps of:

a) generating a network plan using the following substeps:

i) generating a graph which represents the network and which is composed of edges and nodes, the edges representing all transmission paths in the network, wherein a length and a direction of each of the edges is determined as a function of a real topography of street segments and definable cable paths of a particular territory associated with the network, the nodes representing intersections between at least one of the street segments and the definable cable paths,

ii) assigning the users to the graph, each of the users being connected to one of a closest edge of the edges and a closest node of the nodes via at least one service edge,

iii) generating a tree structure by removing unnecessary edges of the edges from the graph so that only one particular connection exists between the main distribution node and each of the users, wherein the particular connection is composed of the at least one service

edge, the edges and the nodes of the tree structure,

iv) determining needs and requirements for each of the users, and

v) determining at least one load of the edges of the tree structure as a function of the needs and the requirements for each of the users to provide a drafted plan; and

b) generating the network according to the drafted plan.--.

REMARKS

This Preliminary Amendment cancels, without prejudice, original claims 1-20, cancels substitute claims 1-20 in the underlying PCT Application No. PCT/EP98/00027, and adds new claims 21-44. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

The amendments to the specification and abstract are to conform the specification and abstract to U.S. Patent and Trademark Office rules, and do not introduce new matter into the application.

The underlying PCT Application No. PCT/EP98/00027 includes an International Search Report, dated June 18, 1998, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

The underlying PCT Application No. PCT/EP98/00027 also includes an International Preliminary Examination Report, dated April 13, 1999, a copy of which is included, including a translation.

Applicants assert that the present invention is new, non-obvious, and useful. Prompt consideration and allowance of the claims are respectfully requested.

Respectfully Submitted,

KENYON & KENYON

By: [signature] Reg No 35,952

Dated: 7/6/99

By: [signature]
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[2345/79]

METHOD FOR GENERATING A NETWORK

Background of the Invention

The present invention concerns a method for generating and optimizing a network, in particular a telecommunications, water, long-distance heat supply, or power network.

Supply, telecommunications, or, for example, computer networks are very difficult for a person to set up by hand once they have grown beyond a certain size. When setting up a network, therefore, the most important consideration is its proper functioning. Once the network has been set up, it can be optimized only at points. In most cases, serious errors can no longer be corrected later on.

Depending on the network type and layout, the widest variety of technologies can be used. Network planners usually have multiple components at their disposal for solving a specific network problem. In the case of telecommunication networks, planners must, among other things, decide whether to use a copper or fiber-optic cable for a specific connection. They must also choose among a wide variety of copper and fiber-optic cable types, all of which vary in terms of their capacities, i.e. transmission rates, number of lines per cable, and maximum possible transmission ranges.

Up to now, network plans for telecommunication networks that will provide coverage for a specific territory have almost always been drawn up manually by experienced network planners. As mentioned above, proper network functioning is the primary concern when drawing up such plans. A network that has been technically optimized and has the most cost-effective layout

cannot be set up using the currently known network generation methods.

The conventional method for setting up a telecommunications network is described below, only the most important principles being explained. Figure 1 shows a territory 1 having individual blocks 2 of houses to be supplied from an exchange (HVK) 7. Blocks 2 have individual users 3, whose phone line requirements 4 are indicated. For purposes of illustration, users 3 in this example do not require any services other than phone lines. Blocks 2 are separated from one another by streets 5 and street intersections 6. As shown in Figure 2, the network planner has divided territory 1 into areas A through E on the basis of the planning rules established in the past by the carrier and of his store of experience, multiple city blocks, such as A1 and A2, usually being combined into one area. These areas are referred to below as cable distribution areas. The territory is divided into cable distribution areas on the basis of the technology to be used and on the basis of the cable typologies defined in the individual countries. The technology determines the maximum and optimum size of the individual cable distribution areas. In the present example, the network planner has selected, e.g., copper cables, it being possible for one copper cable to have different pairings, such as 10, 20, 50, 75, 100, 150 or 200 copper pairs (CuDA). The copper cable transmission range is sufficient for all users, and the maximum capacity of a cable distributor 8 may be 1 00 copper pairs. The network planner then establishes the locations of cable distributors 8 (KVZA - KVZE) from which the distribution cables (VzK) containing the phone lines are run to individual users 3 along the possible routes, i.e. along the sidewalks and underneath intersections 1 1, as shown in Figure 3. The telephone lines

of the particular area, which are bundled into main cables (Hk) 9 are run directly to exchange 7 from cable distributor 8 of the area. If possible, cables 9 are run along existing cable routes of the other areas in order to reduce the cost of laying cables.

As shown in Figure 2, area A must be supplied with at least 68 phone lines, area B with at least 72 phone lines, area C with at least 78 phone lines, area D with at least 57 phone lines, and area E with at least 49 phone lines. This means that multiple copper distribution cables, whose utilization depends on the number of copper pairs needed as well as on the cable typology, must be laid in the individual areas. For example, a 20-pair copper distribution cable is needed for one side of a city block A1 and a 50-pair copper distribution cable for the other side of the block. Because of the way the cable distribution areas are divided up, this means that the copper distribution cables have different filling ratios [volumetric efficiencies].

The cable distribution areas formed in this manner must now be connected to exchange (HVK) 7 via main cables (Hk) 9. For example, a main cable with a net capacity of 49 copper pairs is needed to supply cable distribution area E. This means that the main cable having the next higher pairing of 50 copper pairs, which is preferably used, is utilized at a rate of up to 98%. The planner now has two choices for running the main cable of area E to exchange 7. He can run the main cable along routes to a cable distributor in an area A or D situated closer to the exchange in order to run the main cable of area E, along with the main cables of other areas, to a main cable having a higher capacity or a different technology, such as fiber optics. The planner can run the main cable of area E to

the cable distributor of either area D or A. In the first case, the main cable leading from exchange 7 to the cable distributor of area D must have a minimum capacity of 106 copper pairs (49 copper pairs in area E and 57 copper pairs in area D). In the second case, the main cable leading from exchange 7 to the cable distributor of area A must have a minimum capacity of 117 copper pairs (49 copper pairs in area E and 68 copper pairs in area D). However, since copper cables having a capacity of 117 or 109 copper pairs are not available, the copper cable with the next higher capacity, i.e. 150 copper pairs, must be selected. Using a 150-pair copper cable, the main cable capacity utilization is 70.67% in the first case and 78% in the second case. To select the optimum network version, the cost of both options must now be calculated. This procedure is repeated for all cable distribution areas.

To provide an optimum network design, all possible combinations must obviously be considered when delimiting the areas and routing the main cables. Selecting the wrong edges for the cable distribution areas in the early stages of network planning produces subsequent errors which cannot be corrected later on.

Because it can also take several weeks to set up a large network manually, and networks often must be set up under extreme time pressure, it is usually not possible to develop alternative solutions when defining the areas. The network is therefore not optimized with a view to efficient network utilization and cost minimization.

As a result, the method described above is not likely to enable the network planner to set up the most cost-effective

and profitable network variant.

The object of the present invention is therefore to provide a method which can be used to generate a highly functional, low-cost network having a high level of capacity utilization in the shortest amount of time and with the least amount of work.

According to the present invention, this object is achieved by generating, in a first process step, a graph composed of edges and nodes, the graph including all technically feasible and/or definable network transmission paths, and the length and direction of the edges being derived from the real topography of the street segments and definable cable paths of the territory to be supplied by the network, and the nodes forming the intersections between the edges or streets and/or cable paths; by assigning, in a second process step, the users in the territory to the graph in such a way that each user is connected to the closest edge or the closest node in the graph by an additional service edge; by generating, in a third process step, the most cost-effective tree structure by removing unnecessary edges from the graph so that only one connection between the main distribution node and each user is provided by the edges and nodes in the tree structure; by determining, in a fourth process step, the load carried by the edges in the tree structure according to the user needs and requirements; and by dimensioning and selecting, in a subsequent fifth process step, the technologies to be used for each edge, service edge, and node in the tree structure on the basis of the edge loads calculated in process steps I-IV.

The method according to the present invention can be used to advantageously set up a network which is particularly short in length, allowing it to be generated especially economically

since the costs of materials and laying the cables are low, network capacity utilization, for another thing, being particularly high, keeping the carrier's costs low. The method can be used, in particular, for telecommunications, water, long-distance heat supply, and power networks. By converting the method to a computer program that can run on a data processing system, the generated network can be easily optimized manually later on because certain transmission paths can be permanently defined for the graph, the method being used to produce a network which routes, for example, the telecommunications equipment, in particular the cables, along these transmission paths.

A complete network plan can be drawn up very quickly by applying the method multiple times to different network levels, due to the various technologies used for the levels. If a computer is used, for example, for a telecommunication network, the cable types to be laid, as well as their lengths and pairings, are available in a database immediately upon completion of the method, along with the interconnections needed for each node. This makes it possible to very quickly generate a list of costs and materials. Maps for network construction and maintenance can also be created from the network plan data generated.

In the case of water networks, the required pipe types, along with their diameters and gradients, the necessary pumps and their locations, etc., can be determined directly.

One advantage is that all process steps can be easily completed quickly and conveniently using a computer program, making it possible to generate any number of network plans for a territory in a relatively short amount of time. An optimum network plan can be drawn up gradually by making minor changes

to the defined street and route layout parameters as well as the costs of materials and laying cables and the technology to be used for a specific network level. However, these parameters can also be defined or selected for each step in generating a network plan, using a batch program or, for example, genetic algorithms or evolutionary strategies. Using a computer makes it possible to optimize a network plan without any subsequent manual work.

The method according to the present invention is explained in greater detail below in its individual process steps on the basis of drawings illustrating, by example, the setting up of a telecommunications network.

Figure 1 shows a territory 1 having individual users 3 arranged along streets;

Figure 2 shows territory 1, which was manually divided into areas A-E by a network planner using conventional methods;

Figure 3 shows a network plan for territory 1, which was drawn up manually by a network planner using conventional methods;

Figures 4 through 8 show the method according to the present invention;

Figure 4 shows a graph G inserted into territory 1 using the method according to the present invention, one edge 14 for graph G being provided along each side of each street;

Figure 4a shows a section of territory 1 illustrated in Figure 4, in which the method according to the present invention connects users 3 to graph G via service edges 16;

Figure 4b shows a section of territory 1, in which tree structure Ba is created by connecting users 3 step by step to the portion of the tree structure already created;

Figure 4c shows the tree structure created for territory 1 using the method and load 21 assigned to edges 14;

Figure 5 shows territory 1 having the cable distribution sub-areas created in process steps Va) through Ve) described below;

Figure 5a shows a section of territory 1, with two cable distribution sub-areas being combined to form one cable distribution area 26;

Figure 5b shows a section of Figure 5a, cable distribution area 26 being separated from the tree structure by the two limit edges Gk.

Figure 5c shows a section from Figure 5a, the limit edge of the cable distribution sub-area being connected to closest node 29 with a requirement of 9;

Figure 6 shows territory 1 having the created cable distribution areas 26 and cable distributors

KVZ_1 to KVZ_4 arranged in their distribution centers;

Figure 7 shows new tree structure 33 created using process steps Vq) through Vs), described below;

Figure 8 shows cable distribution areas 26, pairings 35 being assigned to individual edges 14 or street segments.

For territory 1 illustrated in Figure 1, composed of city blocks 2 on which users 3 are arranged at random as well as streets and defined cable paths 5 and their intersections 6, a telecommunication network that connects territory 1 to an exchange 7 is set up using the method, as shown in Figures 4 through 8. For purposes of illustration, only those users 3 who need a service of the same type, such as phone lines, are provided.

Because the method can be applied as often as necessary to specific levels determined by the technologies, exchange 7 can, however, be treated like a distribution node 8.

Figure 4 shows a street graph which was created in process step I. It is assumed that only streets exist, and no defined cable paths. An edge 14 of graph G is assigned to each side of a street. This produces four nodes 15 at street intersections 6, a group of four street intersections 11 forming, in each case, a separate edge 14.

In process step II, which is illustrated in Figure 4a, users 3 are connected to graph G using service edges 16. For this purpose, either the shortest path to graph G from the junction

of particular user 3 must be selected, or service edge 16 must be run along a specific route according to a particular preset parameter, thus determining the length of service edge 16. Where service edge 16 meets an edge 14 of graph G, this edge 14 is split into two edges 14a, and the junction formed by edge 14 and service edge 16 becomes a new node 15a. Edges 14a thus correspond to edges 14.

At the end of process step II, all users 3 are connected to graph G. As shown in Figures 4b and 4c, a tree structure Ba is generated in process step III, each user 3 being connected to exchange 7 via a separate connection, which is composed of service branches 16, edges 14, and nodes 15. For this purpose, graph G is searched for user 17 having the lowest cost of connecting to exchange 7. The connection costs are determined, for example, by the cable technology used and the cost of laying the cables, including the excavation costs. This user 17, edges 14, and nodes 15, which connect the latter to exchange 7, are then marked and form marked transmission path 18 (process step Ia). Next (process step Ib), all users 3 are connected to exchange 7 in succession so that user 19 whose cost of connecting to previously marked transmission path 18 is lower than that of all as yet unmarked users 3, is always connected to exchange 7 first, taking into account previously marked edges 14 and/or nodes 15. The located transmission path is marked along with its user. Process steps la and lb are composed only of simple search algorithms and can be easily applied in the form of a computer program.

Once all users 3 have been marked, i.e., are connected generated tree structure Ba, all unmarked edges 14 and nodes 15 of graph G are eliminated. Instead of eliminating edges 14 and nodes 15, however, it is possible to use only marked edges

14 and nodes 15 for the remaining process steps. The latter variant certainly preferable from a programming standpoint.

Generated tree structure Ba is designed to minimize the connection costs (material and cable laying costs) for the defined, possible routes and cable layouts 5 in territory 1.

When designing a computer program, it can be useful to assign a load 21 to remaining edges 14 of tree structure Ba in process step IV. One possible algorithm is described below. In carrying out the method, however, it makes little difference if a different algorithm is used, and, in each case, if necessary, load 21 of edges 14 is determined in process step V.

The possible algorithm is designed so that load "O" (zero) is initially assigned to all edges 14 of tree structure Ba, moving consecutively from each user 3 to exchange 7 along edges 14 and nodes 15, adding requirement 4 of user 3, where the procedure was last started, to each edge 14 traveled.

After the optimized tree structure or route graph has been drawn up using the process steps described above, the way in which users 3 connected to tree structure Ba are combined into cable distribution areas 26 is described below (Figures 5 and 6), the method continuing to optimize the graph by generating as few cable distribution areas 26 as possible by utilizing the equipment as efficiently as possible.

To generate cable distribution areas 26, the capacity of the individual cable distributors supplying the individual cable distribution areas is first defined (process step Va). This capacity depends on the technology of the cable distributors

used. The capacity determines the maximum number of copper pairs, glass fibers, etc. available for a cable distribution area. The maximum ranges of the transmission equipment to be used in cable distribution area 26 must also be defined, thus limiting the size of cable distribution sub-areas 23 in process step Vb).

Depending on his requirements 4, an individual user 3 can form a single cable distribution subarea 23 or even a separate cable distribution area 26, in which case the requirements can be greater than the capacity defined in process step Va). It is advisable to define these users 3, whose requirements 4 are greater than the cable distributor capacity specified in step Va, as a single cable distribution area 26, each of these users 3 being assigned enough transmission equipment to cover the user's requirements so that node 15 bordering on limit edge Gk of a user 3 of this type is assigned a requirement corresponding to a multiple of the capacity defined in step Va for new tree structure 33 to be created in process step Va), just covering the requirement of user 3; and to then remove this user 3 from tree structure Ba, the node forming the distribution center or location of the cable distributor assigned to user 3.

All markings are subsequently removed from users 3, provided that such markings were previously set.

Tree structure Ba is then searched for an as yet unmarked user 22 located at the end of a branch of tree structure Ba. This user 22 is identified by the fact that the user, along with his service edge 16, is adjacent to a node on which only one edge 14 borders. Starting from this user 22, the planner moves along service edge 16, edges 14, and node 15 in the

direction of exchange 7 until reaching a limit edge Gk. A limit edge Gk is identified by the fact that it is connected to a node 15 bordering on an edge 25 whose load 21 is greater than the load defined in process step Va). An edge 14 can, however, become a limit edge Gk of a cable distribution sub-area 23 as soon as the range, starting from user 22, of the transmission equipment to be used for this cable distribution area 26 (which is also defined in process step Va)) is exceeded, even if limit edge Gk would seem to belong to cable distribution sub-area 23 based on its capacity.

Figure 5 shows all cable distribution sub-areas 23 that are created with the method described. Note that this breakdown into cable distribution sub-areas 23 is unique and can be reproduced.

Using subsequent process steps Vf) through Vp), cable distribution sub-areas 23 are now gradually combined or transformed, if possible, into cable distribution areas 26, making sure that load 30 of combined cable distribution area 26 does not exceed the maximum capacity of cable distributor 8. At the end of these process steps, each user 3 is then clearly assigned to a cable distribution area 26.

When creating cable distribution areas 26, it should also be noted that only adjacent cable distribution subareas 23 can be combined, since the areas will otherwise lack cohesion. This would make it nearly impossible for the carrier to perform maintenance and error analysis work later on because conclusions as to the causes of errors that arise could no longer be made in the event of a malfunction. Areas are adjacent when they border on the same node 15 and lie directly against one another in a clockwise or counter-clockwise

direction.

Process steps Vf) through Vp) are explained in greater detail below on the basis of Figures 5 and 6, Figure 5 depicting the initial situation on which process step Vf) is based, and Figure 6 depicting the end result after completion of process step Vp).

In process step Vf), those cable distribution sub-areas 23 in tree structure Ba are first selected which cannot be combined with any adjacent cable distribution sub-area 24 having a smaller or equivalent load, to form a larger cable distribution sub-area 23 because the total load of both adjacent cable distribution sub-areas exceeds the cable distributor capacity. These cable distribution sub-areas 23 are transformed into cable distribution areas 26 and are removed from the tree structure in process steps Vh) and Vi), the requirements of this new cable distribution area 26 being subtracted from all edges 14 connecting the latter to exchange 7 and ignored when creating the other cable distribution areas 26. Refer to the claims for a detailed description of process steps Vh) and Vi).

Below is a description of how cable distribution sub-areas 23 are combined into larger cable distribution sub-areas 23. As illustrated in Figure 5, the three cable distribution sub-areas 24 are adjacent to the same node 28. None of the three cable distribution sub-areas 24 has yet been affected by the previous process steps since their requirements either do not exceed the cable distributor capacity, or the sum their capacities and that of the adjacent cable distribution subarea does not exceed the cable distributor capacity. The requirement of one cable distribution sub-area 24 can

therefore be derived directly from its limit edge Gk. For example, the three cable distribution sub-areas 23 bordering on node 28 have requirements 9, 77, and 20. The sum of adjacent cable distribution sub-areas 23 yields either 86 or 97. In a subsequent process step, cable distribution sub-areas 24 are then combined into a cable distribution area 26 whose total is the largest, i.e., the two cable distribution sub-areas having a total requirement of 97. This cable distribution area 26 is now separated or removed from the tree structure and/or ignored for the remaining process steps (Figure 5b). If more cable distribution sub-areas 24 were attached to node 28, they could also be combined. However, attention must be paid to ensuring network cohesion. In the current example, however, only one single cable distribution sub-area 24 is attached to node 28. Limit edge Gk of this cable distribution sub-area is now run in the direction of exchange 7 until its end facing away from cable distribution sub-area 23 meets next node 29, to which another cable distribution sub-area 23 is attached. Starting from this next node 29, the load of cable distribution area 26 eliminated earlier is subtracted from edges 14 in the direction of the exchange (Figure 5c). Cable distribution sub-areas 23 continue to be combined until there are no longer any cable distribution sub-areas 23 attached to tree structure Ba. The exact method for combining cable distribution sub-areas 23 into cable distribution areas 26 is described in the claims (process claims Vj) through Vp)). As shown in Figure 6, the method according to the present invention is used to divide the territory into four cable distribution areas 26.

After users 3 have been assigned to created cable distribution areas 26, the individual distribution cables (VzK) connecting the cable distributors to assigned users 3 can be dimensioned.

Process steps Vu) through Vw) are completed for this purpose. Process step Vu) is the first step in dimensioning. Process step Vu) is the initialization step, assigning load "0" (zero) to all edges 14, 37 of tree structure Ba. Requirement 4 of each user is then added in step v), moving along edges 14, 37 from users 3 and along node 15 to the cable distributor of cable distribution area 26 belonging to user 3. In doing this, note that the cable distributors should, if possible, be located in the distribution center of the cable distribution area, the center being mapped to the next node to prevent additional nodes from being created in the network. The distribution center is determined by the profitability of the center to be moved and can be calculated, for example, by distributing users 3 and their requirements 4. A variety of algorithms are known for determining the location of the distribution center or cable distributor, and they can also be used in the method according to the present invention.

In step Vw), a distribution cable VzK, which corresponds to a pairing and whose capacity just covers the load of edge 14, is then assigned to each edge 14, 37. This produces a network plan (Figure 8) for the individual cable distribution areas which immediately reveals which technology or which pairing 25 must be used for cable 34 to be laid, in order to adequately supply the users connected to that cable.

The dimensioning of individual cable distribution areas 26 is thus concluded.

Next, the cable distributors of cable distribution areas 26 must be connected to the exchange. If territory 1 is large, however, it may be necessary to provide additional distribution nodes to supply the cable distributors of cable

distribution areas 26 created first and to combine distribution areas into a new network level. In both situations, process step V can be applied to the tree structure illustrated in Figure 7, although without indicating the requirements of individual users 3, but rather the requirements of cable distribution areas 26 of the previous network level, which is selectively represented by the cable distributors attached to the tree structure. Loads 31 of the edges can again be determined, and cable distribution sub-areas as well as cable distribution areas formed on the new network level. The method can continue to be applied to this network level.

A slightly modified version of the method can also be applied to networks in which the different requirements of the users make it necessary to provide multiple pieces of equipment side-by-side on a network level, the equipment being connected to exchange 7 on the next higher or lower network level, using a single piece of equipment. At the same time, this is also taken into account when delimiting cable distribution sub-areas 23 and cable distribution areas 26.

Those skilled in the art can easily apply the described method according to the present invention to other network systems, such as a long-distance heat supply or water supply network. In these networks, the pipes are also run along routes or streets which are combined or distributed at street intersections. According to the method, these junctions are defined as nodes 15 and the pipe routes as edges 14. Exchange 7 is replaced by a main distribution node of the long-distance heat supply network. Because the requirements represent an abstract number in the method, and the long-distance heat supply requirements of the individual users can also be

represented by a number, the method does not need to be changed in this regard, for example in order to apply it to a long-distance heat supply network.

List of reference numbers:

1 Supply territory

2. City block

3. User

4. User requirements

5. Streets or defined cable path

6. Street or cable intersection

7. Main distribution node (HVK) or exchange (Vst)

8. Distribution nodes (KVZ_A -KVZ_E = cable distributors for areas A-E)

9. Cables with data lines

10. Transmission line to user

11. Street intersection with cable run underground.

12. Cable path to main distribution node.

13. Cable for area E is laid in a cable pit together with part of the cable for area D

14. Edge representing one side of a street

15. Node, junction for the edges (14)

16. Service edge to user

17. User with the lowest cost of connection to the exchange (HVK, 7)

18. Marked transmission path from the exchange (7) to the user (17)

19. User with the lowest cost of connection to marked transmission path 18

20. Users subsequently connected to the previously marked edges (14) and nodes (15) using the method

21. Load on the edges (14)

22. User in process step Vb)

23. Cable distribution sub-area

24. Cable distribution sub-areas (23) whose limit edges (Gk) are attached to the same node

25. Edge in process step Vc)

26. Cable distribution area in process step Vg)

27. Eliminated cable distribution area, process step Vh)

28. Node bordered by the limit edges (Gk) of multiple cable distribution sub-areas (23)

29. Closest node; process step Vi)

30. Requirements of a cable distribution area (26)

31. Load of edges (23)

32. Edges of the new tree structure (33) created in process step Vs)

33. New tree structure created in process step Vs)

34. Distribution cable (VzK)

35. Pairing of distribution cable (34)

36. Node shared by the two cable distribution areas 2 and 4 in which the distribution cables of both cable distribution areas run parallel

37 Edge

A-E Areas in supply territory (1)

Ba Tree structure

CuDA Copper pair

Cu-VzK Copper distribution cable

Gk Limit edge of a cable distribution sub-area (23)

Hk Main cable

HVK Exchange (7)

KVz Terminal for the distribution cable of the cable distribution area

Kvz area Cable distribution area

VzK Distribution cable (34)

What is claimed is:

1. A method for generating a network, in particular a telecommunications, water, long-distance heat supply, or power network, the network connecting all users (3) to a main distribution node (7) depending on the existing or definable local needs and requirements (4) of the individual users (3),
characterized by the following process steps:

I) Generation of a graph (G) composed of edges (14) and nodes (15), the graph (G) including all technically feasible and/or definable transmission paths (5) of the network, and the length and direction of the edges (14) being derived from the real topography of the street segments and definable cable paths (5) of the territory (1) to be supplied by the network, and the nodes (15) forming the intersections between the edges (14) or streets and/or cable paths (5);

II) Assignment of the users (3) to the graph (G) in such a way that each user (3) is connected to the closest edge (14) or the closest node (15) of the graph (G) by an additional service edge (16).

III) Creation of a tree structure (Ba) by removing unnecessary edges (14) from the graph (G) in such a way that the service edges (16), edges (14), and nodes (15) of the tree structure (Ba) form only one connection between the main distribution node (7) and each user (3).

IV) Determination of the load of the edges (14) in the tree structure (Ba), depending on the needs and

requirements (4) of the users (3).

2. The method as recited in Claim 1, characterized in that a subsequent fifth process step V is used to delimit the areas and to dimension and select the technologies to be used for each edge (14), service edge (16), and node (15) of the tree structure (Ba) on the basis of the loads (21) of the edges (14) calculated in process steps I-IV.

3. The method as recited in Claim 2, characterized in that process step II is used to split the closest edge (14) in the graph (G) into two edges (14a) at the junction between the closest edge (14) and the service edge (16); and the junction forms a new node (15a).

4. The method as recited in one of the preceding claims, characterized in that the tree structure (Ba) can be created as follows in process step III:

a) Determine the user (3) whose transmission path to the main distribution node (7) along the graph (G) is the most economical one of all users (3), marking the located user (3) and the edges (14) and nodes (15) that form the transmission path;

b) Then select the user (3) from the number of as yet unmarked users (3) whose transmission path to the main distribution node is the most economical one, taking into account previously marked edges (14) and nodes (15) of the previously marked transmission paths, marking this user (3), as well as the edges (14) and nodes (15) that form this transmission path;

c) Repeat step b) until all users (3) have been marked;

d) Remove from the graph (G) all unmarked edges (14) and nodes (15) in the graph (G).

5. The method as recited in one of the preceding claims, characterized in that the data of the real topography of the street segments and definable cable paths (5) in the territory (1) to be supplied by the network is stored in a first database, and the data of the users (3) is stored in a second database, and the second database stores, among other things, the address, junction coordinates and requirements (4) to be covered by the network for each user (3).

6. The method as recited in Claim 5, characterized in that the graph (G), followed by the tree structure (Ba), is generated from the data in both databases.

7. Method for generating and optimizing a network, in particular a telecommunications network, according to one of the preceding claims, characterized in that each street in the territory can be depicted in process step I by two, in particular, parallel edges (14) during generation of the graph (G), each edge (14) representing one side of a street.

8. The method as recited in Claim 7, characterized in that the users (3) can be connected to the exchange (7) by transmission lines of different types, such as copper lines or copper pairs (CuDA) or glass fibers, and the transmission lines are distinguished from one another by their transmission capacities and maximum ranges, the

cables having different numbers of copper pairs (CuDA) or glass fibers being provided for this purpose, and multiple users (3) being supplied by a cable (VzK) in such a way that the number of telephone and/or data transmission lines needed for one user (3) can be run out from a cable (VzK) passing by one user (3) and leading to another user (3).

9. The method as recited in Claim 7 or 8, characterized in that process step V is divided into the following steps:

a) Define the cable distributor capacity and/or the range of the transmission equipment to be used for the cable distribution area, the capacity being derived, in particular, from the equipment to be used for the cable distributors;

b) Go to a user (22) whose service edge (16) is connected to a node (15) which is connected to only one further edge (14);

c) Starting at the user (3) selected in step b), follow the service edges (16), edges (14), and nodes (15) of the tree structure (Ba) in the direction of the exchange (7) until reaching an edge, referred to below as a limit edge (Gk), which borders a node (15) that is connected to an edge (25) whose load (21) exceeds the capacity and/or the range of the cable distributor or cable distribution area defined in step a);

d) Mark all users (3) that are connected to the exchange (7) by the limit edge (Gk) and assign them

to a cable distribution sub-area (23);

e) Repeat steps b) through d) until all users (3) have been assigned to cable distribution subareas (23).

10. The method as recited in Claim 9, characterized in that process step e) is followed by a process step in which a recursive method is used to combine all cable distribution sub-areas (23) into cable distribution areas (26) so that the load (30) of each cable distribution area (26) does not exceed the capacity of the cable distributor defined in step a); each user (3) is assigned to only one cable distribution area (26).

11. The method as recited in one of the preceding claims, characterized in that the number of cable distribution areas (26) is minimized in process step f).

12. The method as recited in Claim 9 or 10, characterized in that only those cable distribution subareas (23) which are directly adjacent to each other are combined into cable distribution areas (26).

13. The method as recited in one of Claims 10 through 12, characterized in that process step e) is followed by the following process steps:

f) First search the tree structure (Ba) for all cable distribution sub-areas (23) whose load, combined with the load of a directly adjacent cable distribution sub-area (23) which has a smaller or equal load and whose limit edge (Gk) borders on the same node (28), is greater than the capacity derived

in process step a) of the cable distributor;

g) Combine any cable distribution sub-areas (23) of this type located in the tree structure (Ba) into cable distribution areas (26), except for the smallest cable distribution sub-area (23), and carry out process steps h) and i) for the cable distribution area (26);

h) Remove the cable distribution areas (26) formed in process step g) from the tree structure (Ba) and ignore them while generating the remaining cable distribution areas (26) so that all users (3), service edges (16), edges (14), and nodes (15) connected to the exchange (7) by the limit edge (Gk) are separated from the tree structure (Ba) or are ignored when generating the remaining cable distribution areas (26); and subtract the load (30) of the separated cable distribution areas (27) from the assigned load (21) of all edges (14) connecting them to the exchange (7);

i) Then check whether any other limit edges (Gk) of additional cable distribution sub-areas (23) border on the node (15) that connected the separated cable distribution area (27) to the exchange (7); if no additional limit edges (Gk) are present, remove the connecting node (28) as well as the edges (14) and nodes (15) which connect it to the next node (29) on which a further limit edge (Gk) borders.

14. The method as recited in Claim 13, characterized in that additional cable distribution areas (26) can be created

using the following process steps:

j) Look for the node (28) that is connected to only one edge (14) and at least one limit edge (Gk), the load (21) of the edge (14) being higher than all other edges (14) still existing or to be included in the tree structure (Ba);

k) If the sum of the loads of all cable distribution sub-areas (23) adjacent to the located node (28) is less than or equal to the capacity of the cable distributor, combine all of these cable distribution sub-areas (23) into a new cable distribution sub-area (23) whose load is equal to the sum of the individual loads of the combined cable distribution sub-areas (23); then go on to step 1);
If the sum of the loads of all cable distribution sub-areas (23) adjacent to the located node (28) is greater than the capacity of the cable distributor, combine those adjacent cable distribution sub-areas (23) whose total individual loads are the highest, yet lower than the capacity of the cable distributor, thus forming a new cable distribution area (26);
Remove this cable distribution sub-area (23) or the new cable distribution area (26) from the tree structure (Ba), or ignore it when creating cable distribution areas (26); then subtract the load (31) of the eliminated cable distribution area (27) from the assigned load (21) of all edges (14) connecting this cable distribution area (26) to the exchange (7); if any cable distribution sub-areas (23) are still attached to the tree structure (Ba), go to

step f); if not, go to step p);

l) The edge (14) connecting the located node to the exchange (7) is the limit edge (Gk) of the new cable distribution sub-area (23);

m) If this limit edge (Gk) is adjacent to a node (15) on which no further limit edges (Gk) border, look for the next node (29) on which another limit edge (Gk) borders, starting from the limit edge (Gk) and moving toward the exchange (7);

n) If no nodes (29) of this type can be found in step m), the cable distribution sub-area (23) becomes a cable distribution area (26); in this case, go to step p); if a node (29) of this type was found, proceed to step o) to continue applying the method;

o) Connect the limit edge (Gk) of the cable distribution sub-area (23) to the node (29) located in step m); repeat steps f) through n) until step n) branches to step p);

p) This completes the process of creating the cable distribution areas (26).

15. The method as recited in one of Claims 10 through 14, characterized in that the following process steps are carried out after the procedure for creating the cable distribution areas is completed:

q) Determine the distribution center of each cable distribution area in relation to the location and

requirements of each user assigned to the cable distribution area, a node of the cable distribution area forming the distribution center and simultaneously the junction between the cable distribution area and the telecommunications network to be generated;

r) Assign the load of the cable distribution area to each distribution center;

s) Create a new tree structure, marking all nodes and edges of the original tree structure produced in process step III which connect the distribution centers defined as nodes to the exchange (7), and then remove all unmarked users, service edges, nodes and edges from the tree structure or ignore them when performing the subsequent process steps.

16. The method as recited in one of the preceding claims, characterized in that all users (3) whose requirements (4) are greater than the cable distributor capacity set in step Va) are each defined as one cable distribution area (26) prior to completing process step Vf), these users each being assigned enough transmission equipment to cover the requirements of that specific user, so that the node (15) on which the limit edge (Gk) of a user (3) of this type borders is assigned a requirement for the new tree structure (Ba) to be created in process step Vs) which is a multiple of the capacity defined in step Va), thus just covering the requirements of this user, subsequently removing this user (3) from the tree structure (Ba), the node forming the distribution center or location of the cable distributor assigned to the user

(3).

17. Method for determining the load of the edges (14) in the tree structure (Ba) (process step IV) according to one of the preceding claims, characterized in that a load of "0" (zero) is initially assigned to all edges (14) of the tree structure (Ba), and moving from one user (3) to the next along the edges (14) and nodes (15) in the direction of the exchange (7), the requirements (4) of each user is added to each edge (14) traveled.

18. The method for dimensioning the transmission equipment and cables for the cable distribution areas (26) formed in process step V as recited in one of the preceding claims, characterized in that the following process steps are completed consecutively:

u) Assign a load of "0" (zero) to all edges (14) in the tree structure (Ba);

v) Moving from each user (3) along the edges (14) and nodes (15) to the cable distributor of the cable distribution area (26) belonging to the user (3), add the requirements (4) of the user to each edge (14) traveled;

w) Assign to each edge (14) a cable whose capacity just covers the load of the particular edge (14);

x) Assign to each node (15) a piece of transmission equipment which covers the load of that particular node (15).

19. The method as recited in Claim 18, characterized in that process steps IV and Va) to Vs) and steps u) to x) are applied to the new tree structure (33) following process step Vs), defining a different capacity and range for the new cable distribution areas (26) to be created on the new tree level in step Va).

20. Application of a method according to one of the preceding claims using a data processing program.

Abstract

The present invention concerns a method for generating a network, in particular a telecommunications, water, long-distance heat supply, or power network, the network connecting all users (3) to a main distribution node (7) depending on the existing or definable local needs and requirements (4) of the individual users (3), characterized by the following process steps:

I) Generation of a graph (G) composed of edges (14) and nodes (15), the graph (G) including all technically feasible and/or definable transmission paths (5) of the network, and the length and direction of the edges (14) being derived from the real topography of the street segments and definable cable paths (5) of the territory (1) to be supplied by the network, and the nodes (15) forming the intersections between the edges (14) or streets and/or cable paths (3);

II) Assignment of the users (3) to the graph (G) in such a way that each user (3) is connected to the closest edge (14) or the closest node (15) of the graph (G) by an additional service edge (14);

III) Creation of a tree structure (Ba) by removing unnecessary edges (14) from the graph (G) in such a way that the service edges (16), edges (14), and nodes (15) of the tree structure (Ba) form only one connection between the main distribution node (7) and each user (3); and

IV) Determination of the load of the edges (14) in the tree structure (Ba), depending on the needs and requirements (4) of the users (3).

What is claimed is:

1. Method for generating a network, in particular a telecommunication, water, district heating or power network which connects all user residing within the territory to be supplied to a main distribution node, generated by the following method:

A) Generation of a network plan using the following process steps:

I) Generation of a graph (G) representing the trunk network and composed of edges (14) and nodes (15), with the edges of the graph (G) representing all transmission paths in the network, and the length and direction of the edges being derived from the real topography of the street segments and definable cable paths of the territory to be supplied by the network, and the nodes representing the intersections between the streets and/or cable paths;

II) Assignment of the users (3) to the graph (G), with each user (3) is connected to the closest edge (14) or the closest node (15) of the graph (G) by a service edge (14).

III) Creation of a tree structure (Ba) by removing unnecessary edges (14) from the graph in such a way that only one connection, composed of the service

edges (16), edges (14), and nodes (115) of the tree structure (Ba), exists between the main distribution node (7) and each user (3).

IV) Determination of the load of the edges (14) in the tree structure (Ba), depending on the needs and requirements defined for the individual users (3).

B. Generation of the network according to the drafted plan.

2. Method according to Claim 1, characterized in that a subsequent fifth process step V is used to delimit areas and to dimension and select a technology (in particular with respect to a cable or a line to be laid) to be used for each edge (14), service edge (16), and node (15) of the tree structure (Ba) on the basis of the loads (21) of the edges (14) calculated in process steps I-IV.

3. Method according to Claim 2, characterized in that process step 11 is used to split the closest edge (14) in the graph (G) into two edges (14a) at the junction between the closest edge (14) and the service edge (16); and the junction forms a new node (15a).

4. Method according to one of the preceding claims, characterized in that the tree structure (Ba) can be created as follows in process step III:

a) Determine the user (3) whose transmission path to the main distribution node (7) along the graph (G) incurs the lowest provisioning costs compared to the remaining users, marking the located user (3) and the edges (14) and nodes (I 5) that form the transmission path;

b) Then select the user (3) from the number of as yet unmarked users (3) whose transmission path to the main distribution node is the most economical one, taking into account previously marked edges (14) and nodes (15) of the previously marked transmission paths, marking this user (3), as well as the edges (14) and nodes (15) that form this transmission path;

c) Repeat step b) until all users (3) have been marked;

d) Remove from the graph (G) all edges (14) and nodes (15) in the graph (G) which are not marked.

5. Method according to one of the preceding claims, characterized in that the data of the real topography of the street segments and definable cable paths (5) in the territory (1) to be supplied by the network is stored in a first database, and the data of the users (3) is stored in a second database, and the second database stores, among other things, the address, junction coordinates and requirements (4) to be covered by the network for

each user (3).

6. Method according to Claim 5, characterized in that the graph (G), followed by the tree structure (Ba), is generated from the data in both databases.

7. Method for generating and optimizing a network, in particular a telecommunication network, according to one of the preceding claims, characterized in that each street in the territory can be depicted in process step I by two, in particular, parallel, edges (14) during generation of the graph (G), with each edge (14) representing one side of a street.

8. Method according to Claim 7, characterized in that the users (3) can be connected to the main distribution node (7) by transmission lines of different types, such as copper lines or copper pairs (CuDA) or glass fibers, and the connections are distinguished from one another by their transmission capacities and maximum ranges, with cables having different numbers of copper pairs (CuDA) or glass fibers being provided for this purpose and multiple users (3) being supplied by a cable (VzK) in such a way that the number of telephone and/or data transmission lines needed for one user (3) can be run out from a cable (VzK) passing by one user (3) and leading to another user (3).

9. Method according to Claim 7 or 8, characterized in that the area delimitation and the dimensioning and selection of the technology (in particular with regard to a cable or a line to be laid) to be used for each edge (14) is broken down into the following steps:

a) Define the capacity of cable distributors (KVz) and/or the range of the transmission equipment to be used for the cable distribution area, with the capacity being derived, in particular, from the equipment to be used for the cable distributors.;

b) Go to a user (22) whose service edge (16) is connected to a node (15) which is connected to only one further edge (14);

c) Starting at the user (3) selected in step b), follow the service edges (16), edges (14), and nodes (15) of the tree structure (Ba) in the direction of the exchange (7) until reaching an edge, referred to below as a limit edge (Gk), which borders a node (15) that is connected to an edge (25) whose load (21) exceeds the capacity and/or the range of the cable distributor or cable distribution area defined in step a);

d) Mark all users (3) that are connected to the exchange (7) by the limit edge (Gk) and assign them to a cable distribution sub-area (23);

e) Repeat steps b) through d) until all users (3) have been assigned to cable distribution subareas (23).

10. Method according to Claim 9, characterized in that process step e) is followed by a process step in-which a recursive method is used to combine all cable distribution sub-areas (23) into cable distribution areas (26) so that the load (30) of each cable distribution area (26) does not exceed the capacity of the cable distributor defined in step a); each user (3) is assigned to only one cable distribution area (26).

11. Method according to one of the preceding claims, characterized in that the cable distribution sub-areas 23 which cannot be combined with an adjacent cable distribution sub-area 24 having a smaller or equal load, thus forming a larger cable distribution sub-area 23, are selected from the tree structure Ba in process step Vf.

12. Method according to Claim 9 or 10, characterized in that only those cable distribution subareas (23) which are directly adjacent to each other are combined into cable distribution areas (26).

13. Method according to one of Claims 10 through 12, characterized in that process step e) is followed by the following process steps:

f) First search the tree structure (Ba) for all cable distribution sub-areas (23) whose load, combined with the load of a directly adjacent cable distribution sub-area (23) which has a smaller or equal load and whose limit edge (Gk) borders on the same node (28), is greater than the capacity derived in process step a) of the cable distributor;

g) Combine any cable distribution sub-areas (23) of this type located in the tree structure (Ba) into cable distribution areas (26), except for the smallest cable distribution sub-area (23), and carry out process steps h) and 1) for the cable distribution area (26);

h) Remove the cable distribution areas (26) formed in process step g) from the tree structure (Ba) and ignore them while generating the remaining cable distribution areas (26) so that all users (3), service edges (16), edges (14), and nodes (15) connected to the exchange (7) by the limit edge (Gk) are separated from the tree structure (Ba) or are ignored when generating the remaining cable distribution areas (26); and subtract the load (30) of the separated cable distribution areas (27) from the assigned load (21) of all edges (14) connecting them to the exchange (7);

i) Then check whether any other limit edges (Gk) of additional cable distribution sub-areas (23) border

on the node (15) that connected the separated cable distribution area (27) to the exchange (7); if no additional limit edges (Gk) are present, remove the connecting node (28) as well as the edges (14) and nodes (15) which connect it to the next node (29) on which a further limit edge (Gk) borders.

14. Method according to Claim 13, characterized in that additional cable distribution areas (26) can be created using the following process steps:

j) Look for the node (28) that is connected to only one edge (14) and at least one limit edge (Gk), with the load (21) of the edge (14) being higher than all other edges (14) still existing or to be included in the tree structure (Ba);

k) If the sum of the loads of all cable distribution sub-areas (23) adjacent to the located node (28) is less than or equal to the capacity of the cable distributor, combine all of these cable distribution sub-areas (23) into a new cable distribution sub-area (23) whose load is equal to the sum of the individual loads of the combined cable distribution sub-areas (23); then go on to step 1);
If the sum of the loads of all cable distribution sub-areas (23) adjacent to the located node (28) is greater than the capacity of the cable distributor, combine those adjacent cable distribution sub-areas (23) whose total individual loads are the highest,

yet lower than the capacity of the cable distributor, thus forming a new cable distribution area (26);

Remove this cable distribution sub-area (23) or the new cable distribution area (26) from the tree structure (Ba), or ignore it when creating cable distribution areas (26); then subtract the load (31) of the eliminated cable distribution area (27) from the assigned load (21) of all edges (14) connecting this cable distribution area (26) to the exchange (7); if any cable distribution sub-areas (23) are still attached to the tree structure (Ba), go to step f); if not, go to step p);

l) The edge (14) connecting the located node to the exchange (7) is the limit edge (Gk) of the new cable distribution sub-area (23);

m) If this limit edge (Gk) is adjacent to a node (15) on which no further limit edges (Gk) border, look for the next node (28) on which another limit edge (Gk) borders, starting from the limit edge (Gk) and moving toward the exchange (7);

n) If no nodes (29) of this type can be found in step m), the cable distribution sub-area (23) becomes a cable distribution area (26); in this case, go to step p); if a node (29) of this type was found, proceed to step o) to continue applying the method;

o) Connect the limit edge (Gk) of the cable distribution sub-area (23) to the node (29) located in step m); repeat steps f) through n) until step n) branches to step p);

p) This completes the process of creating the cable distribution areas (26).

15. Method according to one of Claims 10 through 14, characterized in that the following process steps are carried out after the procedure for creating the cable distribution areas is completed:

q) Determine the distribution center of each cable distribution area in relation to the location and requirements of each user assigned to the cable distribution area, with one node of the cable distribution area forming the distribution center and simultaneously the junction between the cable distribution area and the telecommunication network being set up;

r) Assign the load of the cable distribution area to each distribution center;

s) Create a new tree structure, marking all nodes and edges of the original tree structure produced in process step II which connect the distribution centers defined as nodes to the exchange (7), and then remove all unmarked users, service edges, nodes

and edges from the tree structure or ignore them when performing the subsequent process steps.

16. Method according to one of preceding claims 13 through 15, characterized in that all users (3) whose requirements (4) are greater than the cable distributor capacity set in step Va) are each defined as one cable distribution area (26) prior to completing process step Vf), with these users each being assigned enough technology to cover the requirements of that specific user, so that the node (15) on which the limit edge (Gk) of a user (3) of this type borders is assigned a requirement for the new tree structure (Ba) to be created in process step Vs) which is a multiple of the capacity defined in step Va), thus just covering the requirements of this user, subsequently removing this user (3) from the tree structure (Ba), with the node forming the distribution center or location of the cable distributor assigned to the user (3).

17. Method for determining the load of the edges (14) in the tree structure (Ba) (process step IV) according to one of the preceding claims, characterized in that a load of "0" (zero) is initially assigned to all edges (14) of the tree structure (Ba), and. moving from one user (3) to the next along the edges (14) and nodes (15) in the direction of the exchange (7), the requirements (4) of each user is added to each edge (14) traveled.

18. Method for dimensioning the transmission equipment and cables for the cable distribution areas (26) formed in process step V according to one of Claims 9 through 17, characterized in that the following process steps are completed consecutively:

u) Assign a load of "O" (zero) to all edges (14) in the tree structure (Ba);

v) Moving from each user (3) along the edges (I 4) and nodes (15) to the cable distributor of the cable distribution area (26) belonging to the user (3), add the requirements (4) of the user to each edge (14) traveled;

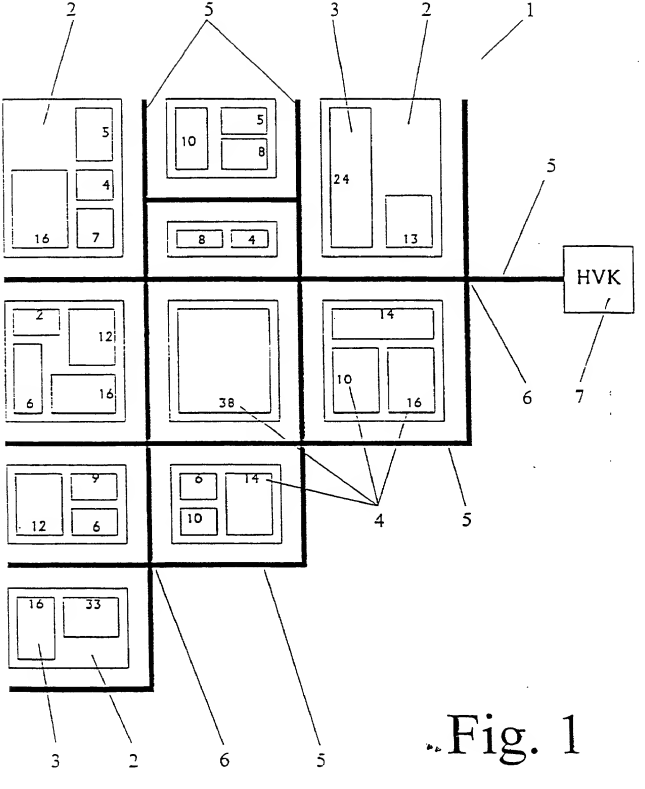
w) Assign to each edge (14) a cable whose capacity just covers the load of the particular edge (14);

x) Assign to each node (15) a piece of transmission equipment which covers the load of that particular node (15).

19. Method according to Claim 18, characterized in that process steps IV and Va) to VS) and steps u) to x) are applied to the new tree structure (33) following process step Vs), defining a different capacity and range for the new cable distribution areas (26) to be created on the new tree level in step Va).

20. Application of a method according to one of the preceding claims using a data processing program.

202305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16
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Fig. 1

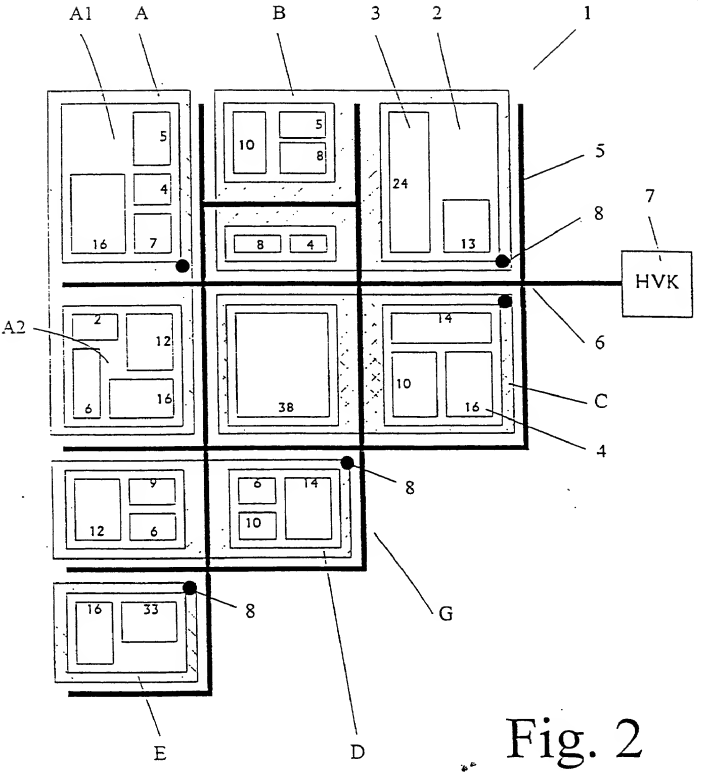

Fig. 2

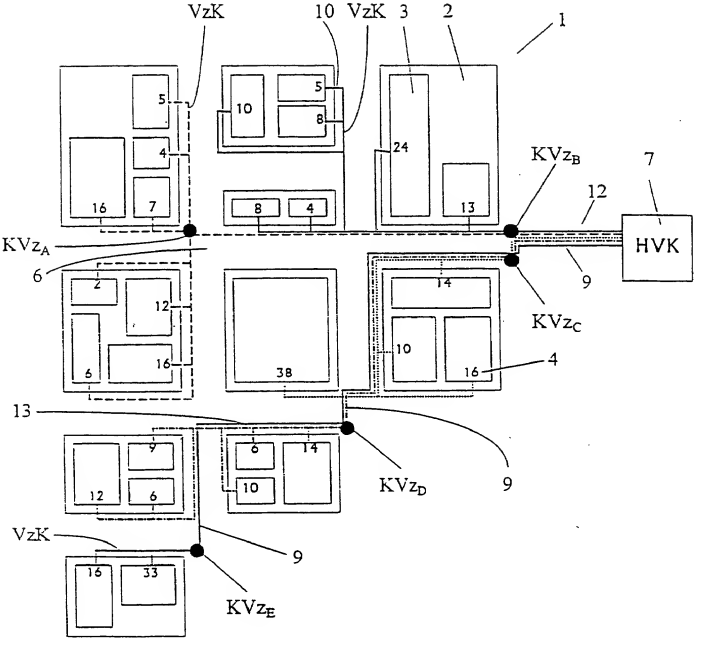
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Fig. 3

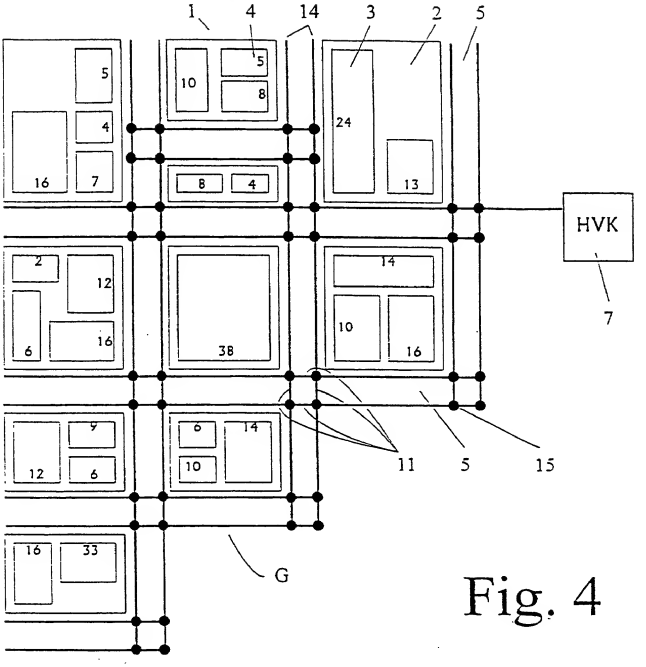


Fig. 4

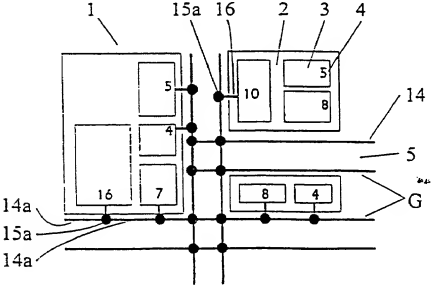


Fig. 4a

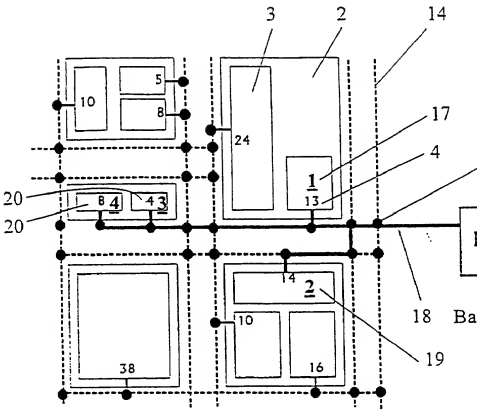


Fig. 4b

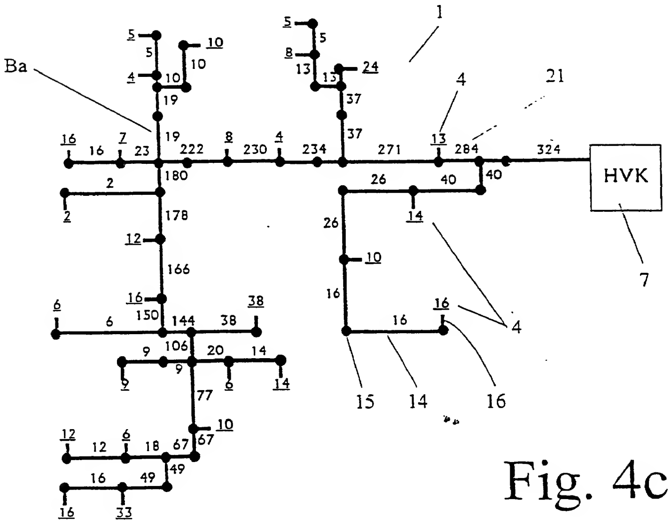


Fig. 4c

09/341232

Fig. 5

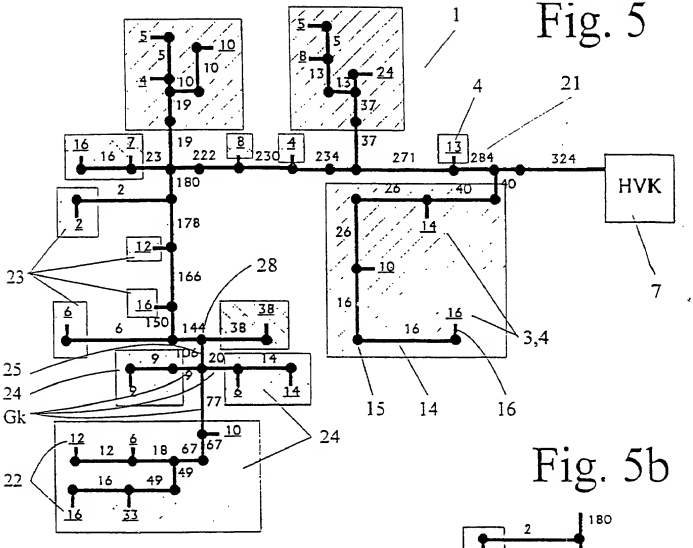


Fig. 5b

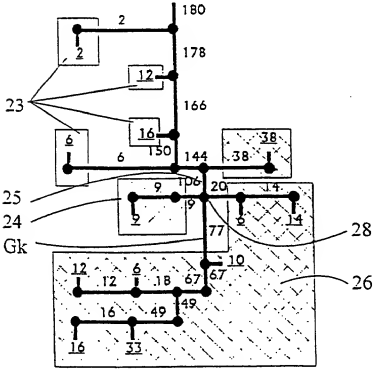
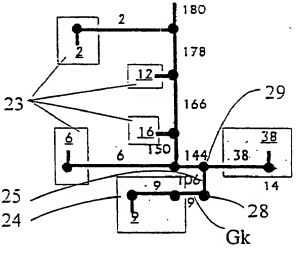


Fig. 5a



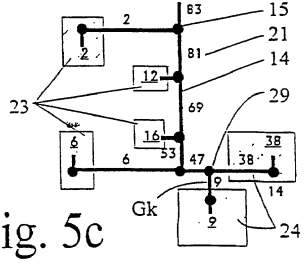
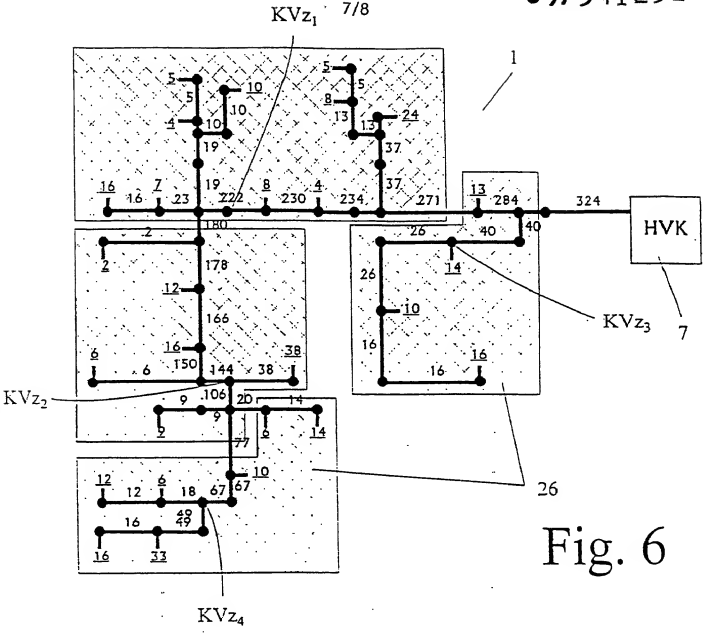


Fig. 5c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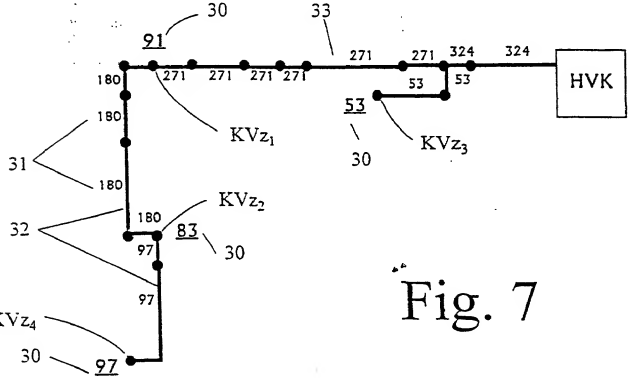
KVz2
KVz4
26

Fig. 6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KVz4
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97

Fig. 7

09/341232

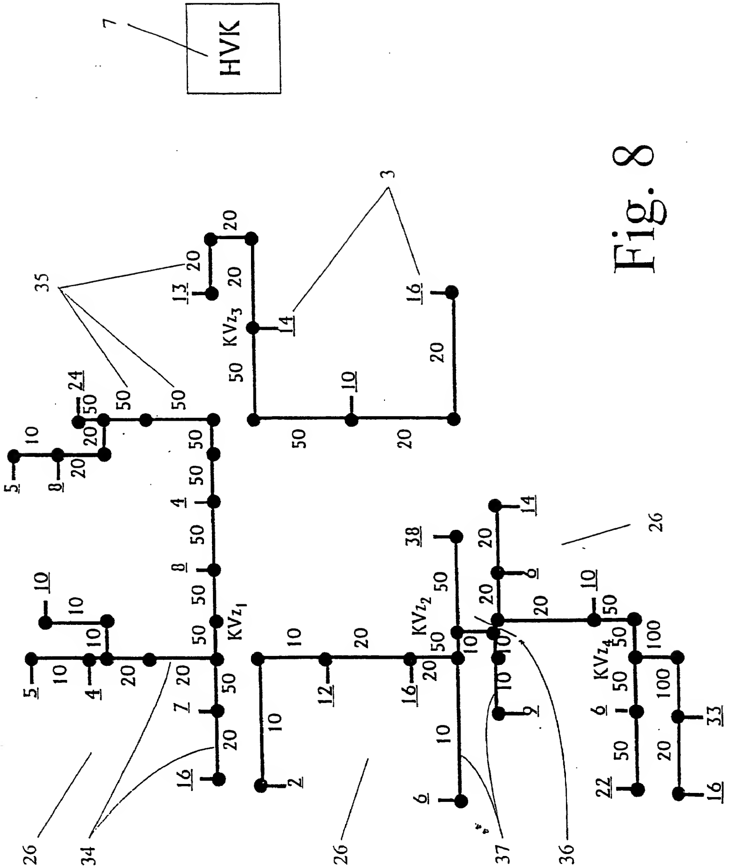

Fig. 8

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD FOR GENERATING A NETWORK**, the specification of which was filed as PCT International Application No. **PCT/EP98/00027 on January 5, 1998.**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country	Day/month/year filed	Priority Claimed Under 35 USC §119
197 00 148.3	Fed. Rep. of Germany	06 January 1997	Yes

And I hereby appoint Richard L. Mayer (Reg. No. 22,490) and Gerard A. Messina (Reg. No. 35,952) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please address all communications regarding this application to:

KENYON & KENYON
One Broadway
New York, New York 10004

Please direct all telephone calls to Richard L. Mayer at (212) 425-7200.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor: **Volker ERNST**

Inventor's Signature: _____

Date: _____

Residence: Berliner Str. 96
D-42929 Wermelskirchen
Federal Republic of Germany

Citizenship: Federal Republic of Germany

Post Office Address: Same as above.

Inventor: **Björn WERTHER**

Inventor's Signature: ____________________

Date: ____________

Residence: Römerstr. 338
D-53117 Bonn
Federal Republic of Germany

Citizenship: Federal Republic of Germany

Post Office Address: Same as above.

Inventor: **Manfred WERTHER**

Inventor's Signature: ______________________

Date: ______________

Residence: Dorfstr. 32
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Federal Republic of Germany

Citizenship: Federal Republic of Germany

Post Office Address: Same as above.

Inventor: **Frank WILLE**

Inventor's Signature: _____

Date: _____

Residence: St. Josephstr. 1
D-53849 Mechernich
Federal Republic of Germany

Citizenship: Federal Republic of Germany

Post Office Address: Same as above.

Inventor: **Roman-Emanuel ZGOLL**

Inventor's Signature: ______________________

Date: ______________

Residence: Beethovenstr. 39
D-53340 Meckenheim
Federal Republic of Germany

Citizenship: Federal Republic of Germany

Post Office Address: Same as above.

#3

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	
DECLARATION AND POWER OF ATTORNEY	ATTORNEY'S DOCKET NO. **2345/79**

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name,

I believe I am an original, first, and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled **METHOD OF PRODUCING A NETWORK,** the specification of which was filed as International Application No. PCT/EP98/00027 on January 5, 1998.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

PRIOR FOREIGN APPLICATION(S)

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. § 119
GERMANY	**197 00 148.3**	**6 January 1997**		**YES**

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorneys:
Richard L. Mayer (Reg. No. 22,490)
William C. Gehris (Reg. No. 38,156)
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I declare that all statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

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Signature	Volker Ernst	Date	June - 18 - 1999
FULL NAME OF INVENTOR 2-00	FAMILY NAME **WERTHER**	FIRST GIVEN NAME **Bjoern**	SECOND GIVEN NAME
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FULL NAME OF INVENTOR 3-00	FAMILY NAME **WERTHER**	FIRST GIVEN NAME **Manfred**	SECOND GIVEN NAME
RESIDENCE & CITIZENSHIP	CITY **D-24358 Ascheffel**	STATE & ZIP CODE/OR FOREIGN COUNTRY **Germany** DEX	COUNTRY OF CITIZENSHIP **Germany**
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Signature X Dr Manfred Werther		Date June 15th 1999	
FULL NAME OF INVENTOR	FAMILY NAME **WILLE**	FIRST GIVEN NAME **Frank**	SECOND GIVEN NAME
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FULL NAME OF INVENTOR	FAMILY NAME **ZGOLL**	FIRST GIVEN NAME **Roman-Emanuel**	SECOND GIVEN NAME
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FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
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Signature		Date	

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FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
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